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Nr. 5. J. P. Jacobsen: CONTRIBUTION TO THE HYDROGRAPHY OF THE ATLANTIC. RESEARCHES FROM THE M/S »MARGRETHE« 1913

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
Trykt hos J. Jørgensen & Co. (Ivar Jantzen)
1916

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CONTRIBUTION

TO THE

HYDROGRAPHY OF THE ATLANTIC

RESEARCHES FROM THE M/S "MARGRETHE" 1913

BY

J. P. JACOBSEN

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
TRYKT HOS JØRGENSEN & CO. (IVAR JANTZEN)
1916

CONTENTS.

	Pages
Introduction	3
Discussion of the observations	6
The renewal of the intermediate water layers in the Atlantic Ocean	9
Diagrams of temperature, salinity and amount of oxygen at the stations	17
The material of observations from the "Margrethe" etc.	18

Introduction.

In a previous paper (1915) I have dealt with the hydrographical material which was collected from the Danish research motor-ship "Margrethe" in the Atlantic around the Faroes in 1913 in connexion with other researches carried on in the same waters. The material which was collected during the rest of the cruise from the Faroe Islands to the Danish West Indian Islands is not as complete as planned, because a not inconsiderable part was lost by the wreck of the vessel in December 1913. However, I think that a publication and brief treatment of this material may not be out of place, because results were obtained by the observations of the amount of oxygen which according to my opinion not only are of value in themselves but also may be of use in the planning of future investigations. To make up for the investigations which had been planned to be carried out from the "Margrethe" in the West Indies, hydrographical measurements and collection of water samples were undertaken from a smaller vessel on the initiative of Johs. Schmidt. The collection of water samples for the determination of the amount of chlorine and oxygen as well as the measurements of temperature were undertaken by Captain G. Hansen who for years has been charged with such investigations by the Danish Commission for the Study of the Sea. The titrations of chlorine and oxygen samples were worked out after the return at the Hydrographical Laboratory in Copenhagen.

The usual methods were employed for the investigations. At the stations taken from the "Margrethe" Ekman's water bottle and Richter's reversing thermometer were employed. By the investigations in the West-Indies Pettersson's water bottle was employed. The water samples for the determination of the chlorine were partly put into bottles with a patent stopper (mineral water bottles) partly into medicine bottles provided with good selected corks, and at the stations taken from the "Margrethe" the collection was arranged in such a way that the two kinds of bottles were used by turns in a depth-series. The size of the bottles was ca. 200 cm^3. For the collection of water samples for the determination of oxygen, bottles with well-ground glass stoppers of a size of ca. 150 cm^3 were employed. The filling of the bottles, the admixture of reagents in view of Winkler's titration, and the keeping of the bottles in glasses with water were carried out as usual.

The position of the different stations may be seen on the chart Fig. 1.

The tables concerning the data obtained by the observations have been published at the end of this paper. p. 18.

As a supplement of considerable interest to the above mentioned investigations are the measurements which have been carried out by Mr. Funder teacher of navigation from the training ship "Viking" on her voyage from Copenhagen to South America and *vice versa*. — Some of the water samples collected on this cruise, among these the oxygen samples, were titrated at the Hydrographical Laboratory after the return; many determinations were however undertaken on board the "Viking".

The position of "Viking"s stations, where determinations of the amount of oxygen were made, have been put down on the chart Fig 2 in this paper.

200 Meter
1000 "
2000 "
3000 "
4000 "
CANADA
LABRADOR
BAFFIN LAND
GRÖNLAND
ISLAND
SPITZBERGEN
NORGE
SVERIGE
FINLAND
RUSSIE
UNITED STATES
NEWFOUNDLAND
SCOTLAND
IRELAND
ENGLAND
DANEMARK
NEDERLAND
BELGIQUE
DEUTSCHLAND
FRANCE
ESPAGNE
AFRICA
A
B
C
33.00
34.00
35.00
36.00
37.00
35.25
The hydrografical stations taken from the „Margrethe" and from a boat.
Curves of salinity; the curves indicating a salinity of less than 37,00 ‰ are referring to August 1913 and are taken from the Bulletin hydrographique 1913-1914, Part A Pl. I; the curve of 37,00 ‰ is referring to November 1913 and is taken from the Bulletin 1913-1914, Part A Pl. II.
+ Places where surface samples are taken.
1000 500 0 1000 2000 Kilometer
100 50 0 1 2 3 4 500 6 7 8 9 1000 naut. miles

Fig. 1.

Fig. 2. • Stations taken from "Margrethe". + Stations taken from "Deutschland".
* » » » "Viking". • » » » "Challenger".
o » » » "Planet".

In the following number of this series, Mr. FUNDER will publish the results of the investigations from the "Viking".

The Director of the Danish Hydrographical Laboratory, Professor MARTIN KNUDSEN, has charged me to bring Mr. FUNDER the Laboratory's best thanks for the considerable work and great interest which he has taken in these investigations.

It is known that Professor G. SCHOTT recently (1912) has published a work dealing with the geography of the Atlantic, in which he has gathered everything essential that is known with regard to

the hydrographical conditions of the Atlantic. A historical record, concerning the different investigations, which had been carried out till 1911, may also be found here.

Of special interest are the newer investigations by which the modern oceanographic methods have been employed. On the German expedition with the S/S "Planet" W. BRENNECKE (1909) has thus investigated the distribution of temperature, salinity and oxygen in a section of the eastern part of the Atlantic from the Channel to the south point of Africa. The stations on this route are marked on the chart Fig. 2 in this paper.

Contributions to the hydrography of the Atlantic have moreover been added by W. BRENNECKE's (1911—12) investigations on "Deutschland"s voyage to the antarctic waters. The stations on this voyage have also been marked on Fig. 2.

About the same time as the investigations from "Margrethe" took place a series of investigations in the Northern Atlantic were carried out by B. HELLAND-HANSEN (1914); observations of temperature, salinity and amount of oxygen were made at different stations situated from the Rockall Plateau to 31° W L. about at the same latitude as Margrethes Stat. $^{22}/_{7}$ (Fig. 2).

We have, essentially in the Southern Atlantic, the old investigations from 1876 from the Challenger Expedition. These have not been carried out according to the modern methods, they are, however, valuable for the sake of comparison with the newer ones. The stations of the Challenger Expedition at which oxygen analyses were carried out are put down on Fig. 2.

It is well known that extensive investigations in the Atlantic were carried out by the Norwegian investigators: HJORT, HELLAND-HANSEN, GRAN and others in connection with the famous naturalist JOHN MURRAY. Up to the present a general account (1912) has only been given; it contains, however, essential contributions for the understanding of the water circulation in the Atlantic.

Among the earlier investigations which I am going to make use of in the following, I may mention those, which MARTIN KNUDSEN (1899) has carried out and treated from the Danish Ingolf Expedition, as well as some of the investigations which were undertaken from the S/S "Thor" by NIELSEN and PALITSCH.

Discussion of the observations.

At the end of this paper the observation material will be found partly in tables, partly in curves for some of the stations. It will be seen that the distribution of salinity for the upper layer has been about what we might expect according to the previous observations at hand. On the chart showing the "Margrethe's" stations (Fig. 1) salinity curves are for the sake of comparison put down for the surface from the Hydrographical Bulletin partly for August 1913, partly for November 1913, as the curves were drawn for the average condition in the respective months on the basis of a considerable observation material.

In Fig. 3 a section has been drawn through some of the "Margrethe's" stations. The situation of the section is marked A on the station chart (Fig. 1.)

From the tables it will be seen that the salinity at ca. 50° N. Lat. and 30 W. Long. (station $^{5}/_{8}$ 1913) is about the same from surface to bottom. That the salinity in this locality has frequently a value of about 35,00 $^{0}/_{00}$ will be seen, if we regard the surface charts which have been published in the Hydrographical Bulletin, and on the surface isohalines a bend will generally be found towards this locality which is evidently due to the low salinity of the inflowing water from the area north of the Newfoundland Banks. The chart, Fig. 1, shows that this bend has been conspicuous at this particular time, its average value for the month of August has however not reached as far south as might be presumed according to the observations from the "Margrethe."

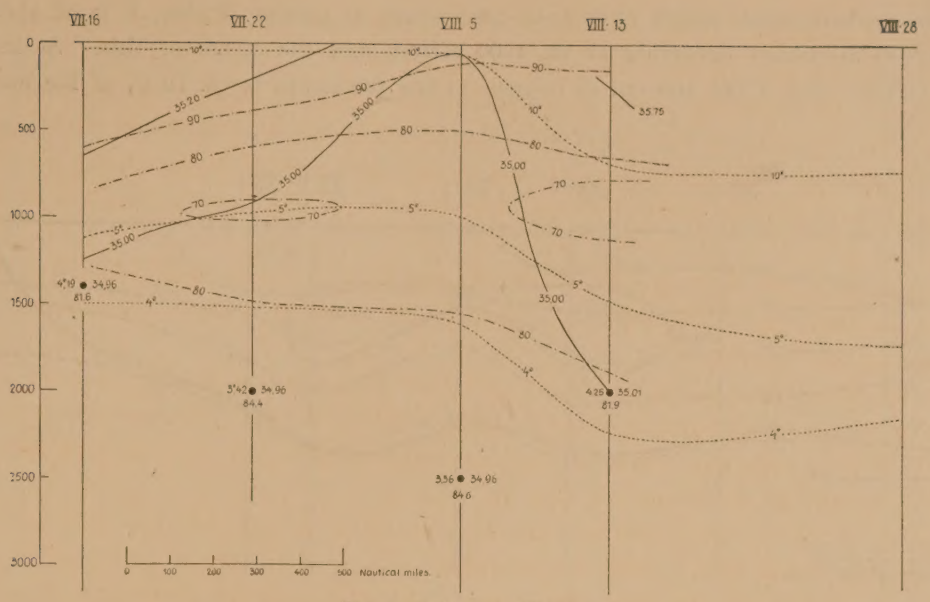


Fig. 3. Section A (Fig. 1.)

For the salinity in the depth a similar distribution was previously (1910) found in about the same locality by the "Michael Sars" Expedition. (Murray and Hjort 1912 p. 115.)

In accordance with the low salinity in the upper layers at ca. 50° N. 30° W. we also find rather low temperatures. More southerly at 42°38′ N., where a series of observations were taken on the $^{13}/_{8}$, considerably warmer and more saline water occurred. South of the New Foundland Banks the characteristic difference in the temperature occurred at "Margrethe's" stations from the $^{15}/_{9}$ and $^{18}/_{9}$. At a depth of 200 metres there is at these two stations a difference in temperature of more than 10° C. The observations of the salinity were unfortunately lost.

The station diagrams show the salinity to be decreasing with the depth at the stations situated in the section mentioned from the Faroes in a south-western direction. The condition is different for the station by St. Croix, where we find a mean value of 35,59 $^{0}/_{00}$ in the surface, but a salinity maximum of about 37,00 $^{0}/_{00}$ at a depth of ca. 150 metres, after which the salinity again decreases with the depth. A similar salinity maximum occurs at this depth at the stations west of the 50° Long. but it becomes less conspicous and is of less value gradually as we from the West-Indies go towards N. E. A view of these conditions is represented in the section Fig. 4 the place of which is marked C. on the situation chart. From St. Croix to the station $^{15}/_{12}$ the isohalines near the surface show a strong inclination, and at ca. 100 metres' depth a maximum of ca. 37,00 $^{0}/_{00}$ occurs. Further towards North-East the salinity in the surface becomes greater, but the salinity maximum in the depth is constantly found. Further Figure 4 shows that in that part of the sea which is represented by the section the 18° isotherm follows quite closely the isohaline 36,50 $^{0}/_{00}$.

The explanation how this distribution of salinity arises will evidently be, that the surface current carries water of a proportionately low salinity from the Antilles northwards to the area west of the Bermudas, while the saline surface water from the areas east of the section flows under it.

In the central part of the Sargasso Sea a distribution of salinity of a similar kind hardly exists. This will be seen from the section Fig. 5 which on the situation chart is marked B. On this a slightly marked salinity maximum occurs at 100 metres' depth at the stations ($^{25}/_{11}$) and ($^{16}/_{11}$), the salinity however decreases with the depth.

In Fig. 6 a chart is represented over the surface salinity in the locality which we have just dealt with. This chart was drawn on the basis of the salinity observations which were collected in the course of some yars (1910—1915) under the direction of Johs. Schmidt for the sake of the eel investigations.

By the measurements, which have been undertaken at greater depths, it is of special interest to notice the oxygen minimum occurring at ca. 1000 metres and the value of this. As indicated by the curves in the section Fig. 3 the amount of oxygen in the minimum is ca. 70 % of the amount which is

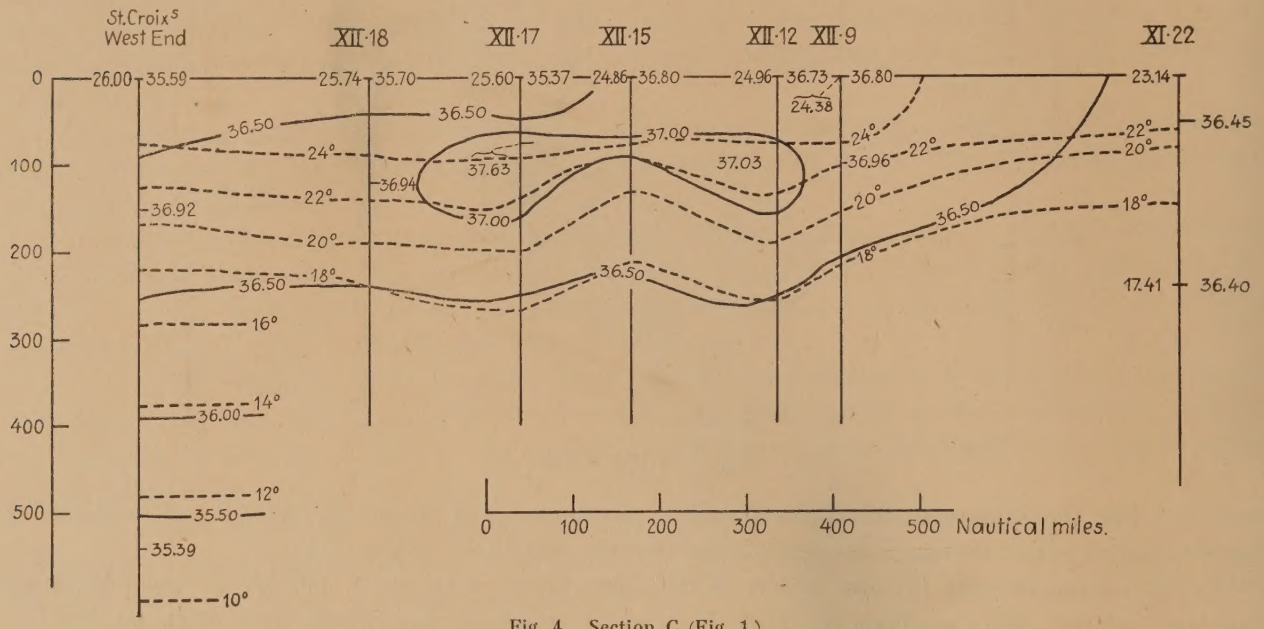


Fig. 4. Section C (Fig. 1.)

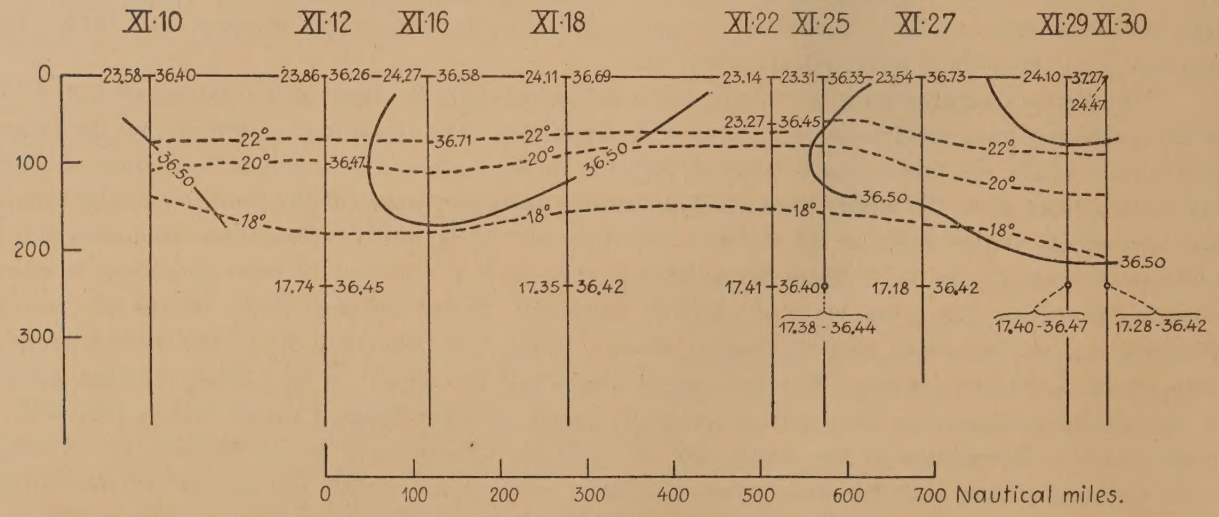


Fig. 5. Section B (Fig. 1.)

necessary for the saturation of the water, and it is to be presumed in accordance with what is generally the case, that the renewal of the layer in which this minimum occurs takes place more slowly than is the case in the upper and under layers.

It will be seen from the tables over the observations from the "Margrethe" that an oxygen-value of 54,9 % was found at a depth of 800 metres at 27° 24′ N. and 52° 40′ W. The observations from the greater depths were unfortunately lost, but we may presume that the value of the minimum here is about 50 %.

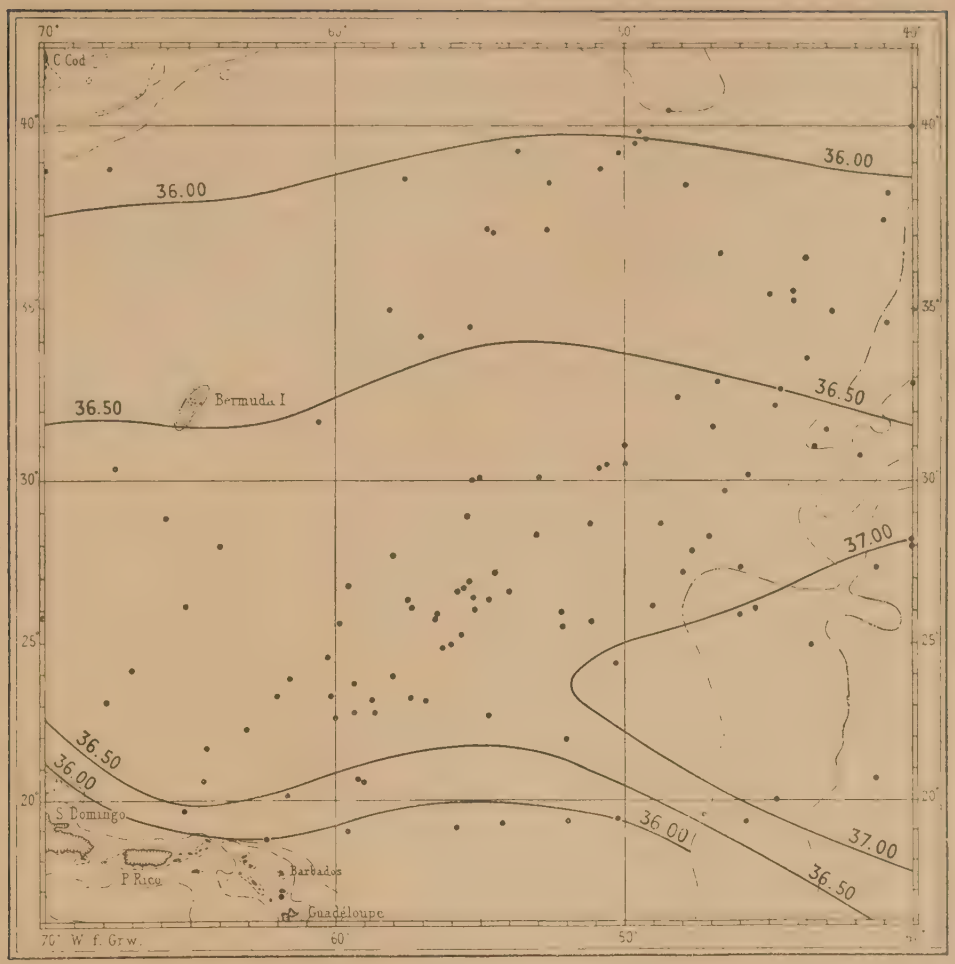


Fig. 6.

At St. Croix a series of measurements from a smaller vessel were carried out at four different times and an oxygen value of ca. 50 % was found at 540 metres' depth; if we presume the distribution of the amount of oxygen at the greater depths in this area to be similar to the other stations having an intermediate minimum, this will probably be of considerably less value than 50 %. Thus there will continually be a decrease in the oxygen value of the middle layer in the northern Atlantic in a direction from the Faroes towards the West Indies.

The renewal of the intermediate water layers in the Atlantic Ocean.

As previously mentioned the investigations from the "Margrethe" have shown the amount of oxygen at ca. 1000 metres' depth to decrease in the stretch from the Faroes to the West Indies. We can hardly find another explanation of this fact than that the water somewhere in the northern part of the Atlantic has been cut off from the atmosphere, after which it has moved towards south-west, gradually becoming deficient in oxygen as this has been used by organisms. It is certain, however, that the amount of oxygen occurring in a certain water mass in the depth depends on different factors, such as the amount of oxygen which the water contains when cut off from the atmosphere, the amount used per time-unit, the amount

developed per time-unit, the time that has passed since it was cut off, together with physical conditions: diffusion, mixing with waters from adjacent layers and, if there be a question about the relative amount of oxygen, then the conduction of heat must also be considered. It will thus be seen that the amount of oxygen is not as constant an indicator for the water as the salinity; it has, however, the advantage that the variations are generally greater, and in proportion to these the changes which may occur in the amount of oxygen due to mere physical causes in the sea play quite an inferior rôle. Then concerning the development and consumption of oxygen by organisms, it must be presumed that with regard to the upper layers (e. g. to ca. 100 metres' depth) there may exist conditions so heterogeneous that they would demand more special investigations than those which can be made on the basis of mere oxygen observations, if they should really be explained. At the depth the conditions are more regular, in the case in question there is for instance hardly any reason to suppose the consumption of oxygen at the depth in the tropics to be predominant in proportion to the consumption in the northern regions; the opposite might rather be expected. It is at any rate my intention in the following to start from the hypothesis, that low amounts of oxygen in the depths in question indicate, that a rather long period has passed since the water was cut off from the surface. A closer investigation of the development and consumption of oxygen in the different areas of the sea will be a future problem, and it is almost beyond doubt that the study of this in connexion with the distribution of oxygen will enable us to obtain valuable results concerning the water circulation in the sea. If we thus suppose the middle layer at ca. 1000 metres' depth to be formed by surface water originating somewhere in the northern regions, the question will be, how this takes place. To be employed by this investigation hydrographical data characteristic of the oxygen minimum at the different stations have been put down in Table 1.

Table 1.

Station	Depth	Oxygen %	Temp.	Salinity	σ_t
$^{16}/_{7}$	1000	75	5.54	35.05	27.67
$^{22}/_{7}$	950	69	5.2	34.97	27.66
$^{5}/_{8}$	1250	74	5.1	34.97	27.66
$^{13}/_{8}$	900	67	5.1	35.22	27.46
$^{10}/_{10}$	$>$ 1000	$<$ 54	$<$ 7.3	—	—
St. Croix	$>$ 540	$<$ 50	$<$ 10.8	$<$ 35.4	

It will be seen that the temperature and salinity in the oxygen minimum somewhat increases from north to south. This can partly be explained in the way, that the water carrying the oxygen minimum gradually becomes mixed with the upper warmer and more saline water towards the south, partly that the oxygen minimum, for reasons that cannot be controlled, may shift somewhat in a vertical direction.

The station curves show that the variation in the temperatures with the depths is generally most prominent in the vicinity of the oxygen minimum. The specific gravity in the locality where the oxygen minimum occurs is characteristic of values of σ_t between 27,67 and 27,46.

For the sake of comparison with these values some data as to the distribution of oxygen and the respective temperatures and salinities in the northern regions will be of interest. Such data are at hand from stations in the area by the Faroes from 1910, due to S. Palitzsch (Bulletin hydrographique 1909—1910). To give a general survey I have divided them into two groups marked I. and K. in Fig. 7 and formed averages of the observations for the different depths inside each group. In this way the following values were found:

Depth in metres:		100	200	300	400	500	600	700	800	900	1000	1100	1200
Amount of Oxygen %	Group I.	97.1	95.5	94.4	94.1	90.3	87.7	84.4	83.8	83.3	82.6		82.8
	" K.	95.8	95.2	94.0	93.9	89.3	85.6	83.8					

It will be seen that the amount of oxygen decreases with the depth. At 500 mestres' depth it is ca. 90 % and decreases utterly to ca. 83 % at 1000 metres' depth. It is a well known fact (KNUDSEN 1899 p. 105, NIELSEN 1907 p. 13. NANSEN 1912 p. 18) that the water which from the depth in the Norwegian Sea makes its way over the Faroe—Iceland Ridge contributes to the formation of the bottom layer in the Atlantic. Presuming at the outset, that this water with regard to the amount of oxygen does on the whole

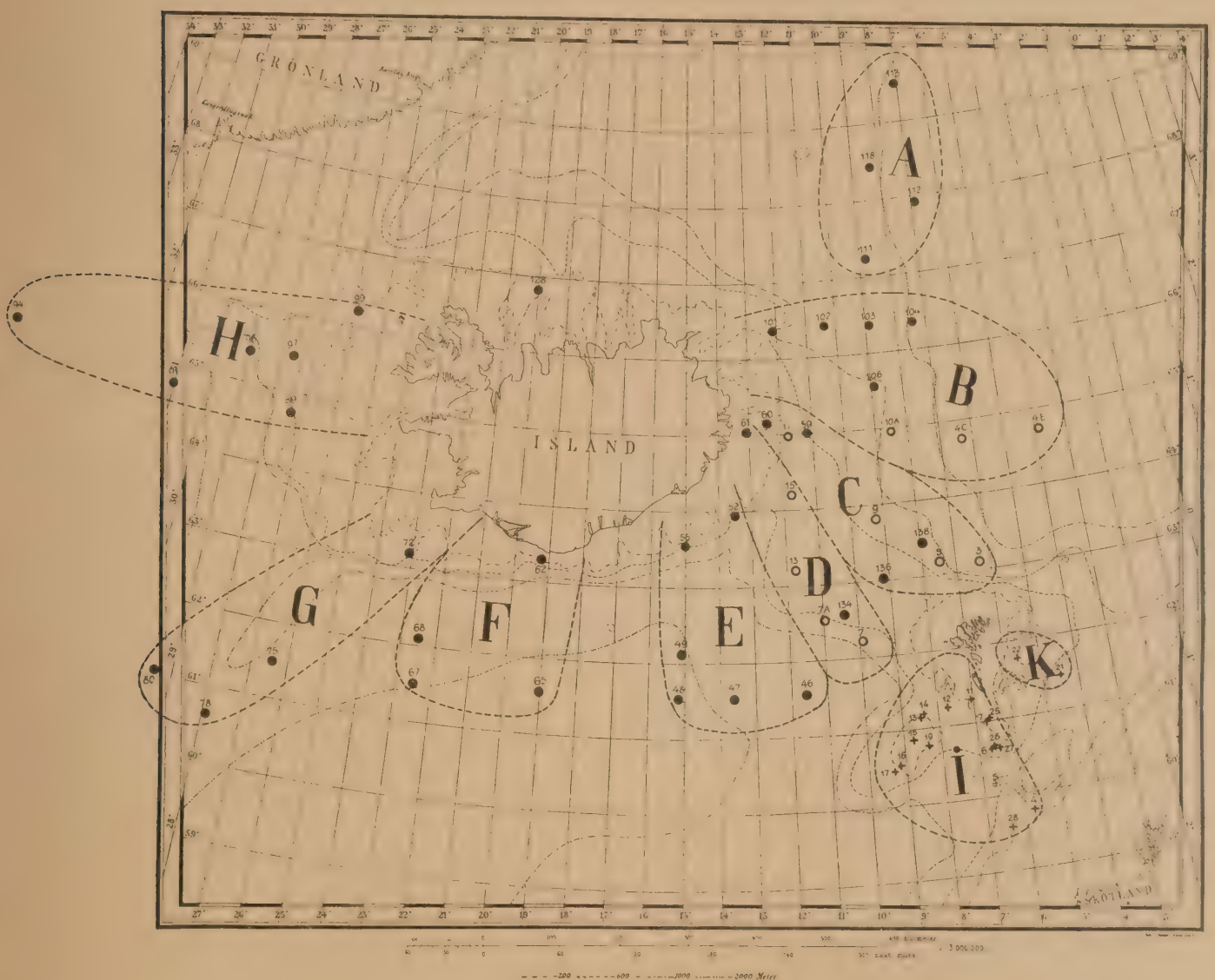


Fig. 7.

possess the same qualities as the water at the observed stations in the Faroe-Shetland Channel, it will be seen that the amount of oxygen of the water which sinks to the bottom in the Atlantic must be ca. 85 %. Above this water we find at the Faroes at 300—400 metres' depth water of a temperature of ca. 5° and a salinity of ca. 35.12 ‰. This consists mainly of Atlantic water mixed with water from the East-Icelandic polar current, and it goes under the Atlantic water coming from south-west and contributes to the formation of the intermediate layer. On account of its proportionately great amount of oxygen (94 %) its different components can not in mean value for long have been cut off from the influence of the atmosphere. Contrary to this the water from the Norwegian Sea which over the treshold flows into

the depth has for a long period been cut off from the atmosphere, the amount of oxygen being thus only ca. 85 %. Conditions similar to those at the Faroe—Iceland Ridge occur but on a greater scale at the ridge uniting Iceland with Greenland. In a paper (1912) concerning the bottom water and its cooling off in the sea FRIDTJOF NANSEN has investigated the conditions for a renewal of the bottom water in the Atlantic by water sinking from these areas, and he has indicated an area east and south-east of the southern part of Greenland at depths between 2000 and 3000 metres to be the place where the renewal of the bottom water in preference takes place.

For the renewal of the bottom water in the Weddell Sea, BRENNECKE has (1915 p. 58) carried out investigations and has found, that the water which sinks to the bottom, is formed in the less deep areas of the sea surrounding the Antarctic Continent and he remarks with regard to this fact, that it differs from NANSEN's hypothesis concerning the formation of the bottom water in the northern part of the Atlantic.

The material available will presumably not allow us to approach the question concerning the origin of the bottom water more closely than shown by NANSEN's investigations. Nevertheless I think it possible that the sinking down of the surface-water that forms the bottom-water also can occur in a way different from those set forth by NANSEN. NANSEN calculates (1912 p. 25) that σ_t for the surface water which should sink to depths of 3000 metres should be 27.91 the adiabatic temperature alteration has being taken into consideration. For the area where NANSEN presumes the formation of the bottom water to take place, we find according to SCHOTT's handbook Pl. XI, XII and XIII the mean values for the year's temperature ca. 5°5, the year's mean value of σ_t ca. 27.20 and the annual variation in temperature ca. 7°. These figures require a yearly variation of σ_t between the limits 26.71 and 27.56. To this comes moreover the variation in σ_t which is due to the variation in the surface salinity; it is probable that the surface salinity is highest during the coldest months, owing to the formation of ice as set forth by NANSEN, and NANSEN's chart representing the surface salinity for the month of April (1912 p. 28) also shows greater value than SCHOTT's mean chart. Finally different unperiodical changes in the position of the isohalines and in the conditions of temperature will naturally occur, thus it will easily be understood that the value of σ_t in the surface 27,91 as NANSEN's hypothesis demands, may be reached, at any rate at times during the cold season, even if it does not pass much beyond that. However, even if the specific gravity of the surface water by the refrigeration in winter may reach and partly exceed the specific gravity of the bottom water, it will still be lower for the greater part of the year, and when it from its lowest value in summer rises on account of the refrigeration, the surface water will for the greater part of the year only reach down into the intermediate layers, if we presume these to have a lesser specific gravity than the bottom water. If the specific gravity were constant from the bottom and up to a depth of e. g. 100 metres, the convection currents would appear when the refrigeration of the surface layer has reached so far that its specific gravity was the same as for the bottom water, and the conditions demanded in order that refrigerated surface water should sink quite to the bottom would be more favourable. To judge from the observations from the Ingolf Expedition (MARTIN KNUDSEN 1899 Pl. XVII) the increase in the specific gravity from the intermediate layers towards the bottom is not high in the area investigated by NANSEN, but even if the specific gravity of the surface water were a little higher than the specific gravity of the bottom water before the sinking down began, the sinking movement would require some time owing to the feeble motive power. Thus there is a possibility that horizontal currents may carry the sinking water masses to places where they, mixed with other water masses, come to form intermediate layers. Thus without denying the possibility, that refrigerated surface water east and southeast of the South point of Greenland may contribute to the formation of the bottom water in the Atlantic, it seems to me that with the observation material at hand as a basis, we may also presume that it contributes especially to the formation of the intermediate layers.

It is without doubt, as set forth by NANSEN, that the water flowing from the Norwegian Sea over the lower parts of the ridge that unites Iceland with Greenland, contributes to the formation of the

bottom water in the Atlantic, as it from the proportionately slight depths of the ridge moves along the bottom downwards to the greater depths. I think it probable that a movement of a similar kind takes place in the water from the area with slight depths north-west and west of Iceland. According to NANSEN's surface chart for April (1912. p. 28) the 34.9 ‰ surface isohaline is in this locality situated between the 0° and 2° surface isotherm and in the vicinity of both, thus the conditions are evidently present that this water during the cold season may obtain a sufficiently high specific gravity (ca. 28.00) to enable it along the bottom to sink down into the depth. To this comes moreover that the movements of the water, the tides and currents caused by wind and by the distribution of specific gravity together with the friction against the bottom in the shallower waters, produce a far stronger mixing up than takes place over the depth, so that the cooling influence of the atmosphere may make itself more felt than over the great depths. Thus I think it likely that a possibility exists here for an essential contribution to the formation of the bottom water in the Atlantic, especially because this water, by following the bottom, may reach the depth without being too much mixed up with the water in the intermediate layers.

If we suppose the renewal of the water in the middle and bottom layer roughly to take place in the here quoted way, we obtain a natural explanation of the fact that the amount of oxygen is lower in the intermediate layer than it is in the bottom layer, as the movement in the water from the less deep parts of the sea along the bottom carries the amount of oxygen, which by the convection currents has been absorbed from the atmosphere, while the convection currents in the deeper areas occur less intensely, thus the supply of oxygen to the intermediate layer consequently takes place more slowly. For a closer examination of the connection between the movement of the water and its contents of oxygen we will take into consideration some results of oxygen analyses which have previously been undertaken. The oxygen analyses at hand from the waters around Iceland are only few in number, the majority were

Table 2. The mean values for the degrees of saturation with oxygen at depths from 100 to 2400 metres in the areas marked in Fig. 7.

Depth metres	A	B	C	D	E	F	G	H	I	K
100		83,1		99,5		85,5			97,1	95,8
200	92,5	101,2	91,7						95,5	95,2
300			88,2						94,4	94,0
400	91,8		90,3	92,4			83,5	92,6	94,1	93,9
500			95,0						90,3	89,3
600		88,5	79,2	84,7	88,2			91,8	87,7	85,6
700				84,3					84.4	83,8
800		85,2	87,3		83,5	79,5		89,5	83,8	
900									83,3	
1000		87,3	80,7						82,6	
1100	87,0					60,9	77,0			
1200									82,8	
1300										
1400		80,9			82,0			97,5		
1500							79,7			
1600						81,2				
1700		87,8	90,2							
1800		88,9			81,9					
1900					82,9					
2000		86,5								
2100						77,1				
2200					81,2					
2300								83,0		
2400	87,6									
Mean	90	88	88		83	77	80	91		

undertaken by the Danish Ingolf Expedition (MARTIN KNUDSEN 1899) and some by I. N. NIELSEN on a cruise with the "Thor" 1903 [1]).

The stations at which the samples were taken are stated on Fig. 7. If we convert the observed amounts of oxygen into the figures for the degree of saturation [2]) by which should be understood the proportion between the oxygen at hand and the amount required for saturation, we find for the surface generally figures in the vicinity of 100 % which is what might be expected. In several cases the degree of saturation has, however, been higher, up to 110 %; this can easily be explained in the way that a development of oxygen under the influence of the light has taken place by plankton organisms in the upper layers; it is also possible that alterations in temperature may have caused alterations in the relative amount of oxygen. From 100 to 2400 metres' depth the degree of saturation is inside the different sea areas more constant, and as we only have 1 to 2 determinations for each respective station, I have in order to obtain a summary survey arranged the results into groups, which on Fig. 7 are marked A, B, C, and so on. When inside one separate group several samples were taken at the same depth, mean numbers were first calculated for this depth, then mean figures of such mean values between 100 and 2400 metres; two of the samples from the Ingolf Expedition to which was applied te term "muddy" were not included in this calculation. By the method in question the mean values given in Table 2 were found.

From the stated figures it will be seen in the first instance, that the degree of saturation is lowest for the areas E, F and G south of Iceland; from these an increase at both sides east and west of Iceland to mean value of ca. 90 % is noticed. If we regard the numbers for the different depths inside the separate areas, there seems to be a tendency to a minimum for the degree of saturation at about a depth of 1000 metres such as is the case more southerly in the Atlantic. In area H west of Iceland higher degrees of saturation occur, even 97.5 % at 1400 metres' depth; this value was found at station 96 of the Ingolf Expedition at the bottom. The temperature is stated to be 1.2°, the salinity 35.11 ‰, which gives σ_t=28.15.

It will be seen that the oxygen analyses from the Faroes, which have been mentioned p. 10, and the oxygen analyses which were carried out from the sea around Iceland supply the picture which we on the basis of the observation material from the "Margrethe" may form concerning the contribution of the amount of oxgen in the northern Atlantic, and from the assumptions made we must presume the intermediate water layer to be renewed in the water area at Iceland by the convection currents, after which its main movement is directed south or south-east without coming in contact with the atmosphere.

Of great interest in this connection are the Norwegian observations of the amount of oxygen (HELLAND-HANSEN 1914) in the section from the Rockall Plateau to 31° W. L., about at the same latitude as the staton M $^{22}/_{7}$ of "Margrethe"; the observations show a minimum in the amount of oxygen in full accord with the observations from "Margrethe".

As mentioned by HELLAND-HANSEN (1914 p. 78) it is to be seen from the Norwegian section that the minimum in the amount of oxygen is situated below the warm water of the Atlantic current and lower in the eastern than in the western part of the section in accordance with the extent of the current.

From the south-eastern part of the Atlantic we have the excellent oxygen determinations from the "Planet Expedition" (BRENNECKE 1909), by which we obtain a similar picture of the movement of the intermediate water layer in the southern Atlantic as in the northern. In the southern regions the amount of oxygen is great in the intermediate water layers, and from these it moves up towards the Equator with a continually decreasing amount of oxygen. The stations from "Planet"s journey are marked on the chart Fig. 2. At 13° 16′ N. Lat. "Planet"s station 9 the oxygen minimum occurs at a depth of 600 metres and has the value 23.6 %. Also at "Planet"s more northerly situated stations an oxygen minimum occurs in the intermediate layer. Its value increases however towards north and is for station 1 at 46° 52′ Lat. 70.2 %

[1]) Bulletin du bureau du conseil, August 1903.

[2]) JACOBSEN's tables 1905 were used for the calculation.

at a depth of 800 metres, and it is thus to be presumed that the intermediate water layer in the eastern part of the northern Atlantic is partly renewed by water coming from northern and western areas. A special rôle, quantitatively however of lesser importance, is played by the water coming from the Mediterranean and moving north as an intermediate layer (NIELSEN 1907 p. 22). For further knowledge about the amount of oxygen in the intermediate water layers in the Atlantic, we have, however, the measurements which were carried out on the German Antarctic Expedition[1]). The position of the stations is marked on the chart Fig. 2, and the relative amounts of oxygen are stated in Table 3. For the three stations: D 22, D 53 and

Table 3.

Station	D 22	D 53	D 70	D 90	D 109
Date	26. V. 1911	10. VII. 1911	5. VIII. 1911	28. VIII. 1911	11. XI. 1911
Lat.	42° 04′ N	7° 30′ N	9° 15′ S	34° 23′ S	54° 27′ S
Long.	28° 22′ W	39° 20′ W	34° 00′ W	48° 04′ W	31° 07′ W
Depth	100 $0_2/0'_2$	100 $0_2/0'_2$	100 $0_2/0'_2$	100 $0_2/0'_2$	100 0_2 $0'_2$
0	109.0	96.9	96.7	99.3	96.6
50	100.9	97.5	96.7		97.1
75		96.0			
100	94.7	57.7	97.5	97.4	94.9
125		47.9			
150		47.6	79.1		82.3
200	95.8	46.1	65.7	87.7	73.0
300			35.7	81.3	
400	83.2	37.6	54.3	79.4	61.0
600	.		46.2	81.7	58.8
800	65.5	43.2	50.4	78.1	60.2
1000	71.1	45.6	55.3	71.2	
1200	77.9		57.0		
1500	82.7	61.3	64.8		60.0
2000				68.7	61.6
2550	83.7				
3000			74.3		
4232				57.1	
4594			59.1		
4836		67.6			

D 70 we have the usual oxygen minimum which for Station D 70 reaches down to 35.7 % at a depth of 300 metres. Temperature and salinity were at this depth at Station D 70 11°, 12 and 35.03 ‰, which is both a higher temperature and a higher salinity than occurs at "Planet"s station 24 at about the same latitude at the depth 400 metres where the amount of oxygen was about minimum, the temperature, salinity and amount of oxygen being here respectively 8°,1, 34,74 ‰ and 16.3 %. At Station D 53 the salinity was proportionately low at the oxygen minimum's depth 400 metres, viz. 34.67 ‰. The water originates probably at the depths of 300—400 metres at Station D 70 mainly from the water masses coming from north, while it at Station D 53 mainly arrives from the south. It is worth while to notice that the oxygen minimum in the vicinity of the Equator occurs considerably higher than further north in accordance with the ascending movement of the water at the Equator.

The chart, Fig. 2, shows that "Margrethe"s Station $^{13}/_{8}$ is situated close by D 22 from May 1911, the position as well as the value of the oxygen minimum are also about the same for both stations.

For the two stations D 90 and D 109 the variation in the amount of oxygen with the depth differs from the stations which we have previously observed, and also the conditions are different with regard to temperature and salinity.

On the voyage with the "Viking" which was mentioned in the introduction, determinations of the

[1]) BRENNECKE: Annalen der Hydrographie etc. 1911, p. 353, 469 and 644, also 1912 p. 126.

amount of oxygen at lesser depths were undertaken at two stations in the Atlantic and at one station in the Pacific. The position of the stations is marked on the chart Fig. 2. The result are set forth in Table 4.

The two stations from the Atlantic are situated in the vicinity of the two German stations D 70 and D 90. If the determination from 165 metres' depth at the "Viking"s Station VII. 7. be correct, the amount of oxygen has thus at that time been considerably lower than when the German station was taken. At Station IX. 16. a similar variation in the amount of oxygen with the depth occurs as at D 90

Table 4.

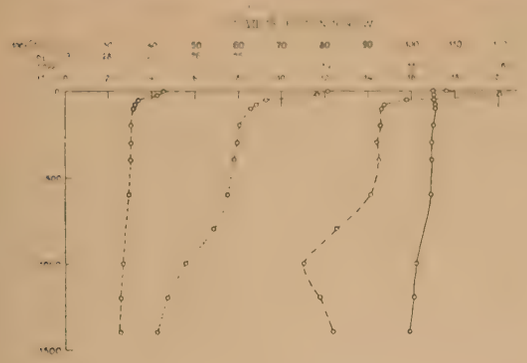
1913 VII. 4. 12° 18′ S 34° 38′ W		1913 IX. 16. 32° 56′ S 45° 46′ W		1914 IV. 17. 34° 35′ S 91° 10′ W	
Depth	100 $0_2/0'_2$	Depth	100 $0'_2/0_2$	Depth	100 $0'_2/0_2$
0	94.7	0	95.5	8	98.5
20	90.7	12	93.7	16	99.0
30	91.9	40	94.5	50	98.4
165	48.7	70	94.0	95	102.3
		140	75.1	175	81.6
		260	83.8	350	84.5
		400	75.8	520	70.7
		500	71.9		

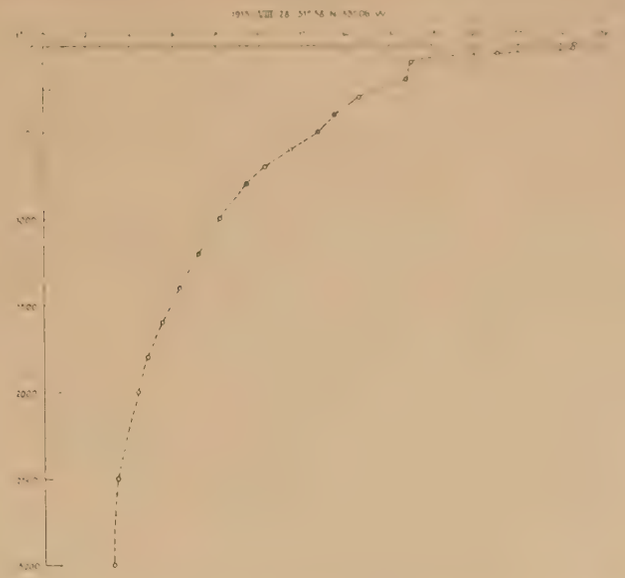
For the sake of comparison with the oxygen analyses in question from the Atlantic and the south-eastern Pacific we have finally the determinations of oxygen which in 1875 and 1876 were carried out on the "Challenger Expedition". The stations where samples were taken, are marked on the chart Fig. 2. As only a few samples were taken at each station, I have arranged the stations into groups, in order that the distribution of the amount of oxygen according to depths may be presumed to be fairly homogeneous inside each group; the results are stated in Table 5. The amounts of oxygen are indicated in per cents in the usual way; for the calculation of the amount necessary for saturation the chlorine amount of 19.5 $^0/_{00}$ was used. Of special interest is Group III which in the main is in full accord with the observations from the "Planet", which was already noticed by Brennecke (1909 Pl. 22). Group II is also in the main concordant with the measurements from D 90 in 1911. On the other hand we must, however, admit, that some of the samples from the "Challenger Expedition" may hardly be presumed to have yielded the correct values, and a comparison between results obtained by methods as different as those which have been employed here should always be undertaken with some reservation.

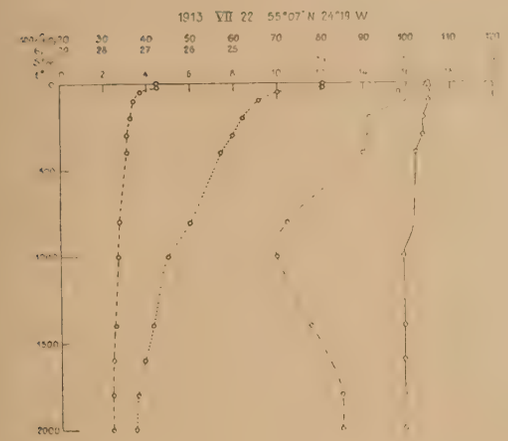
Table 5.

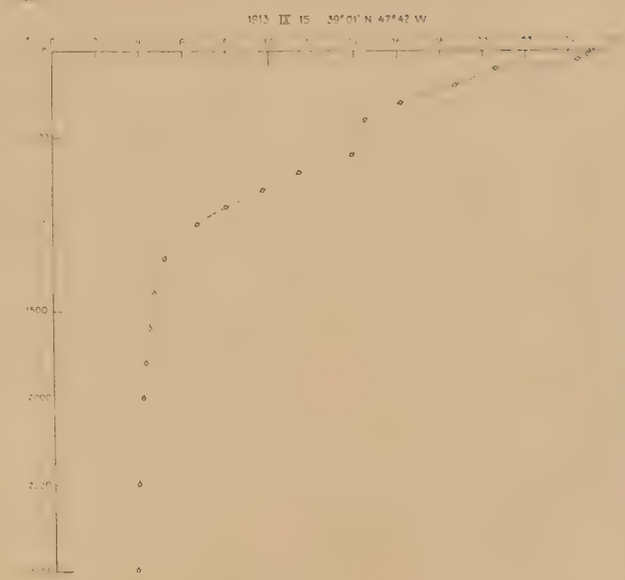
I			II			III			IV		
Stat.	Depth metres	Oxygen $^0/_0$	Stat.	Depth metres	Oxygen $^0/_0$	Stat.	Depth metres	Oxygen $^0/_0$	Stat.	Depth metres	Oxygen $^0/_0$
296	0	103	318	0	97	337	0	101	353	0	95
299	0	[87]	326	0	96	340	0	97	354	0	98
300	0	104	327	0	94	345	0	99	354	183	84
301	0	101	329	0	97	345	46	102	353	4508	56
309	0	100	325	37	101	350	46	92	—	—	—
299	18	[56]	333	183	83	338	91	99	—	—	—
298	46	[85]	331	1463	57	339	183	74	—	—	—
296	91	107	334	1463	65	346	183	49	—	—	—
299	91	79	332	2560	69	349	549	24	—	—	—
300	91	87	323	3475	63	351	549	25	—	—	—
311	448	90	333	3703	70	341	732	44	—	—	—
306 a	631	61	332	4023	60	343	777	47	—	—	—
302	2652	46	325	4846	75	348	1463	47	—	—	—
294	3246	51	324	5121	62	342	1646	71	—	—	—
—	—	—	—	—	—	347	2743	[28]	—	—	—

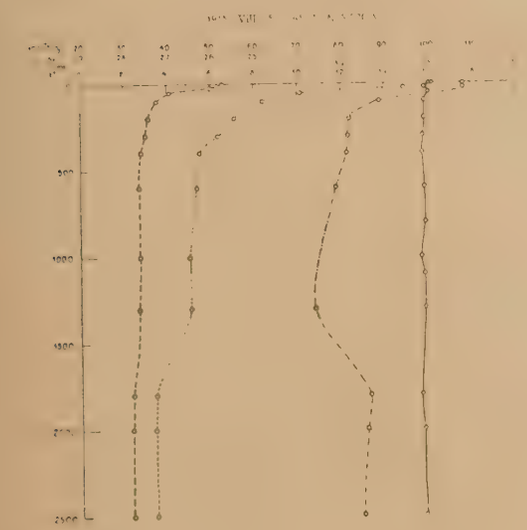
Diagrams of temperature, salinity and amount of oxygen at the stations.

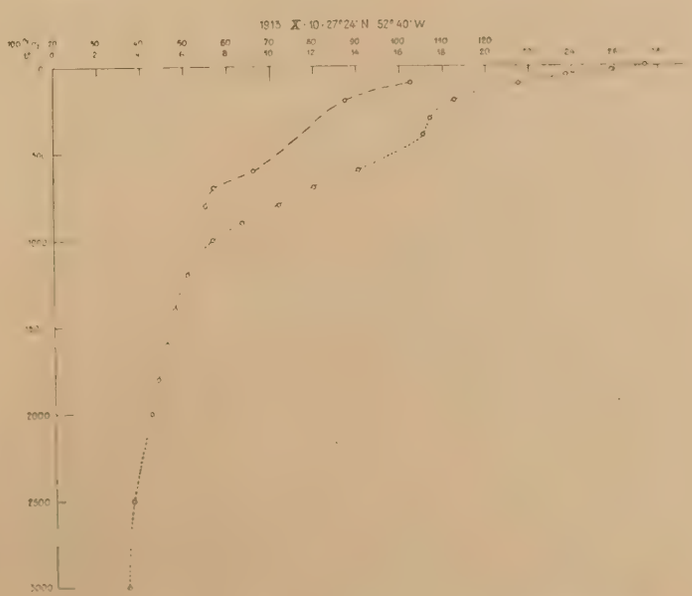


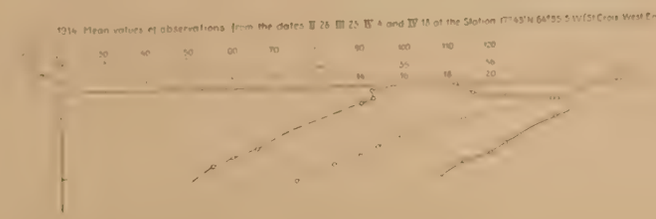












The material of observations from the "Margrethe" etc.

Observations as to temperature, salinity and amount of oxygen.

m	t^0	S ‰	σ_t
1913. VII. 14.	61° 11′ N	11° 54, W	
0	11.31	35.25	26.94
10	34	25	91
25	10.54	26	27.08
100	8.39	30	47
1913. VII. 16.	60° 12′ N	16° 40′ W	
0	12.11	35.25	26.77
20	11.63	26	88
50	9.29	26	27.30
75	8.79	28	39
100	54	28	43
200	05	25	47
300	7.91	23	48
400	77	23	50
600	50	21	54
800	6.83	—	—
1000	5.54	35.05	27.67
1200	4.71	01	74
1400	19	34.96	75
1913. VII. 19.	57° 27′ N	20° 07′ W	
0	—	35.37	—
10	11.85	35	26.91
100	9.55	37	27.34
1913. VII. 22.	55° 07′ N	24° 19′ W	
0	12.08	35.25	26.78
20	09	25	77
50	10.02	25	27.16
100	9.15	25	30
200	8.41	19	38
300	7.95	19	45
400	37	10	45
800	5.98	08	64
1000	4.91	34.96	67
1400	25	97	76
1600	3.86	97	80
1800	53	96	82
2000	42	96	83
1913. VII. 31.	50° 21′ N	26° 55′ W	
0	16.16	35.52	26.12
10	17.15	52	25.89
20	15	—	—
35	14.09	35.52	26.58
50	12.35	—	—
1913. VIII. 4.	49° 46′ N	30° 01′ W	
0	15.58	35.28	26.08
10	59	28	07
20	59	26	06
100	11.23	48	27.12

m	t^0	S ‰	σ_t
1913. VIII. 5.	48° 31′ N	31° 26′ W	
0	16.21	35.03	25.74
20	14.88	34.97	26.01
50	10.15	35.01	96
100	8.40	34.97	27.22
200	7.10	97	41
300	6.35	94	48
400	5.52	94	59
600	37	97	64
800	—	97	—
1000	5.04	92	27.63
1100	—	97	—
1300	5.09	97	27.67
1800	3.42	92	80
2000	39	94	82
2500	36	96	83
1913. VIII. 13.	42° 38′ N	30° 42′ W	
0	22.16	35.86	24.84
20	20.86	90	25.24
50	15.64	88	26.52
100	13.84	86	90
200	12.84	77	27.03
300	57	71	05
400	15	66	09
600	10.91	48	18
800	8.91	25	34
1000	7.35	21	56
1200	6.51	25	69
1400	5.51	16	75
1600	4.77	08	79
1800	69	03	75
2000	25	01	79
1913. VIII. 28.	31° 38′ N	33° 06′ W	
0	24.66	—	—
20	61	—	—
50	21.07	—	—
100	17.09	—	—
200	16.81	—	—
300	14.61	—	—
400	13.52	—	—
500	12.77	—	—
600	11.43	—	—
700	10.19	—	—
800	9.38	—	—
1000	8.09	—	—
1200	7.15	—	—
1400	6.25	—	—
1600	5.43	—	—
1800	4.78	—	—
2000	31	—	—
2500	3.37	—	—
3000	19	—	—

m	t^0	S ‰	σ_t
1913. IX. 3.	28° 00′ N	37° 57′ W	
0	24.96	—	—
20	81	—	—
50	23.91	—	—
75	22.15	—	—
100	20.57	—	—
200	18.54	—	—
250	16.26	—	—
1913. IX. 14.	37° 54′ N	46° 47′ W	
0	23.89	—	—
10	81	—	—
25	76	—	—
50	66	—	—
75	22.41	—	—
85	21.08	—	—
100	19.85	—	—
125	10	—	—
150	18.69	—	—
200	18	—	—
250	17.86	—	—
1913. IX 15.	39° 01′ N	47° 42′ W	
0	25.11	—	—
20	24.91	—	—
50	46	—	—
100	20.61	—	—
200	18.74	—	—
300	16.17	—	—
400	14.49	—	—
600	13.87	—	—
700	11.39	—	—
800	9.70	—	—
900	8.01	—	—
1000	6.69	—	—
1200	5.10	—	—
1400	4.61	—	—
1600	41	—	—
1800	19	—	—
2000	07	—	—
2500	3.87	—	—
3000	77	—	—
1913. IX. 18.	40° 34′ N	48° 53′ W	
0*)	19.56	—	—
5*)	60	—	—
15*)	66	—	—
40	15.96	—	—
50	11.16	—	—
75	8.71	—	—
100	21	—	—
200	58	—	—

*) Observations at 6 a. m.

m	t^0	S ‰	σ_t
1913. IX. 20.	42° 19′ N	50° 22′ W	
0*)	19.26	—	—
5*)	36	—	—
15	22.06	—	—
25	19.61	—	—
35	18.56	—	—
40	14.36	—	—
50	13.66	—	—
75	12.86	—	—
100	11.26	—	—
200	9.47	—	—
*) Observations at 6 a. m.			
1913. IX. 20.	43° 01′ N	50° 24′ W	
0**)	13.76	—	—
5**)	61	—	—
10	10.76	—	—
15	8.06	—	—
20	5.16	—	—
25	4.16	—	—
50	1.36	—	—
87	0.36	—	—
**) Observations at 6 p. m.			
1913. IX. 27.	39° 56′ N	52° 17′ W	
0	22.46	—	—
45	23.56	—	—
100	21.36	—	—
1913. X. 9.	28° 21′ N	52° 40′ W	
0	26.00	—	—
5	76	—	—
15	81	—	—
40	81	—	—
50	16	—	—
62	22.72	—	—
75	21.91	—	—
100	20.67	—	—
200	18.06	—	—
250	17.51	—	—
1913. X. 10.	27° 24′ N	52° 40′ W	
0	27.40	—	—
20	25.84	—	—
50	23.68	—	—
100	21.50	—	—
200	18.52	—	—
300	17.38	—	—
400	09	—	—
600	14.02	—	—
700	11.99	—	—
800	10.37	—	—
900	8.65	—	—
1000	7.29	—	—
1200	6.11	—	—
1400	5.56	—	—
1600	17	—	—
1800	4.73	—	—
2000	39	—	—
2500	3.56	—	—
3000	29	—	—

m	t^0	S ‰	σ_t
1913. X. 24.	30° 55′ N	58° 48′ W	
0	25.04	—	—
10	08	—	—
25	08	—	—
50	24.27	—	—
66	21.69	—	—
75	35	—	—
100	20.09	—	—
1913. X. 28.	32° 21′ N	64° 15′ W	
0	24.46	—	—
10	54	—	—
25	67	—	—
50	23.36	—	—
66	22.09	—	—
75	21.74	—	—
100	20.48	—	—
1913. XI. 10.	32° 03′ N	62° 01′ W	
0	23.58	36.40	24.85
10	58	—	—
25	56	36.40	24.85
50	37	—	—
68	22.96	36.40	25.03
75	21.94	64	50
88	04	60	72
100	20.37	60	92
125	19.01	—	—
250	18.06	—	—
1913. XI. 12.	31° 58′ N	58° 04′ W	
0	23.86	36.26	24.65
10	92	24	62
25	84	26	66
50	71	26	70
68	22.61	44	25.16
75	21.68	47	44
88	20.44	45	77
100	19.86	47	94
125	18.78	45	26.21
240	17.74	45	46
1913. XI. 16.	31° 40′ N	55° 49′ W	
0	24.27	36.58	24.78
10	31	—	—
25	34	—	—
50	32	36.58	24.76
63	32	—	—
69	22.89	36.69	25.27
75	11	71	50
88	21.04	71	80
100	20 41	67	94
125	19.76	71	26.14
155	18.84	58	29
185	17.70	42	45
240	16.48	29	65

m	t^0	S ‰	σ_t
1913. XI. 18.	30° 53′ N	52° 47′ W	
0	24.11	36.69	24.91
10	29	65	83
25	20	67	86
50	19	65	86
63	21.93	—	—
69	36	36.67	25.68
75	20.58	64	88
88	19.77	64	26.09
100	16	60	22
125	18.57	45	27
155	17.90	44	42
185	64	42	46
240	35	42	53
1913. XI. 22.	30° 23′ N	48° 17′ W	
0	23.14	—	—
10	31	—	—
25	32	—	—
50	23.27	36.45	24.97
53	27	—	—
56	27	—	—
60	22.02	36.47	25.35
63	21.28	47	55
75	20.11	47	87
100	18.98	47	26.17
120	47	—	—
240	17.41	36.40	26.51
1913. XI. 25.	29° 24′ N	48° 08′ W	
0	23.31	36.33	24.87
10	36	—	—
25	36	36.33	24.85
50	31	—	—
53	22.17	36.47	25.30
54	21.66	—	—
55	60	36.47	25.46
75	20.21	58	93
100	19.07	58	26.23
120	18.54	51	31
240	17.38	44	54
1913. XI. 27.	28° 22′ N	46° 20′ W	
0	23.54	36.73	25.10
10	58	—	—
25	58	—	—
50	58	36.71	25.07
62	51	—	—
68	22.40	36.78	25.47
75	21.74	67	57
100	20.34	78	26 04
120	19.20	65	25
150	18.08	45	39
180	17.49	—	—
240	18	36.42	26 57

m	t^0	S ‰	σ_t
1913. XI. 29.	25° 34′ N	46° 06′ W	
0	24.10	37.27	25.34
10	21	—	—
25	22	—	—
50	20	37.27	25.31
68	16	—	—
75	10	37.25	25.31
75	10	—	—
76	19	37.27	25.32
76.5	22.28	—	—
78	23	—	—
78	23	—	—
79	06	—	—
80	29	—	—
82	17	36.94	25.66
88	21.93	94	73
100	26	94	92
120	20.40	85	26.08
150	19.29	71	26
180	18.52	58	37
240	17.40	47	56
1913. XI. 30.	24° 46′ N	46° 06′ W	
0	24.47	—	—
10	58	—	—
25	58	—	—
50	58	37.18	25.13
68	23.76	18	38
75	17	00	42
88	21.99	36.94	71
100	06	94	97
120	20.67	92	26.07
150	19.37	74	27
180	18.67	64	38
240	17.28	42	55
1913. XII. 2.	22° 39′ N	46° 15′ W	
0	24.73	—	—
10	88	—	—
25	92	—	—
50	86	—	—
75	86	—	—
97.5	42	—	—
100	23.85	—	—
101	24.21	—	—
103	23.76	—	—
104	22.97	—	—
105	66	—	—
110	41	—	—
120	05	—	—
140	20.98	—	—
160	49	—	—
170	24	—	—
180	19.04	—	—
240	17.74	—	—

m	t^0	S ‰	σ_t
1913. XII. 3.	21° 47′ N	47° 11′ W	
0	25.02	—	—
10	15	—	—
25	15	—	—
50	17	—	—
62	13	—	—
68	24.44	—	—
75	23.84	—	—
88	22.94	—	—
100	30	—	—
120	02	—	—
150	20.90	—	—
180	35	—	—
195	19.27	—	—
210	18.73	—	—
240	17.84	—	—
1913. XII. 5.	23° 00′ N	49° 57′ W	
0	24.86	—	—
10	94	—	—
25	94	—	—
50	96	—	—
75	96	—	—
82	21	—	—
88	23.58	—	—
100	22.90	—	—
120	02	—	—
150	21.36	—	—
180	20.28	—	—
195	03	—	—
215	19.01	—	—
240	18.18	—	—
1913. XII. 6.	23° 36′ N	51° 17′ W	
0	24.76	—	—
10	79	—	—
25	79	—	—
50	80	—	—
63	58	—	—
68	28	—	—
75	23.17	—	—
100	22.06	—	—
120	21.45	—	—
150	20.08	—	—
180	19 07	—	—
210	18.37	—	—
240	17.57	—	—
1913. XII. 8	24° 43′ N	52° 18′ W	
0	24.87	—	—
10	94	—	—
25	25.01	—	—
50	16	—	—
68	24.40	—	—
75	23.91	—	—
88	20	—	—
100	22.63	—	—
120	21.88	—	—
150	17	—	—
180	20.21	—	—
210	18.88	—	—
240	08	—	—

m	t^0	S ‰	σ_t
1913. XII. 9.	25° 35′ N	53° 13′ W	
0	24.38	36.80	24.91
10	46	—	—
25	46	—	—
50	46	36.80	24.89
60	46	—	—
64	46	—	—
66	19	—	—
68	23.13	36.80	25.28
75	22.60	71	36
100	21.78	96	79
120	40	—	—
135	20.86	36.94	26.03
150	04	—	—
165	19.41	36.67	26.21
180	18.77	56	30
240	17.56	—	—
1913. XII. 12.	25° 32′ N	54° 41′ W	
0	24.96	36.73	24.68
10	25.06	—	—
25	07	—	—
50	24.86	36.78	24.73
75	05	37.03	25.19
88	23.09	03	46
100	22.70	—	—
120	18	—	—
150	21.46	37.03	25.93
180	20.38	—	—
190	19.79	36.89	26.28
200	13	69	30
210	18.56	58	36
240	12	56	46
1913. XII. 15.	23° 58′ N	57° 15′ W	
0	24.86	36.80	24.77
10	96	—	—
25	92	—	—
50	89	36.83	24.79
75	23.92	37.03	25.23
81	54	03	34
85	03	36.96	43
88	22.47	82	48
100	21.46	83	78
110	20.86	71	85
120	33	69	98
150	19.30	62	26.20
180	18.43	62	42
240	17.75	44	46
1913. XII. 17.	22° 13′ N	58° 36′ W	
0	25.60	35.37	23.46
10	68	—	—
25	38	35.75	23.81
40	61	—	—
42.5	81	36.17	23.99
45	26.99	—	—
50	27.10	—	—
56	26.86	—	—
62	32	37.07	24.51

m	t^0	S ‰	σ_t
75	25.10	37.63	25.32
81	24 61	—	
88	01	—	—
100	23.29	36.92	25.33
120	22.40	37.03	67
150	21.96	01	78
165	75	07	87
180	20.66	36.89	26.04
195	29	87	12
210	19.46	73	24
240	18.50	55	35

1913. XII. 18. 20° 26′ N 61° 03′ W

0	25.74	35.70	23.67
10	66	—	—
25	26.38	36.06	23.73
50	46	71	24.20
62	25.33	58	46
75	24.66	85	86
100	23.57	92	25.24
120	22.77	94	49
135	21.91	92	72
150	52	—	—
180	20.22	—	—
210	18.89	36.62	26.31
240	01	47	41

1914. II. 28. St. Croix West End. 17° 43′ N 64° 55.5 W

0	25.80	35.48	23.48
25	55	48	55
50	32	48	62
75	32	36.49	24.39
100	24.48	78	86
200	20.09	80	26.13
300	16.62	26	58
350	15.50	00	65
400	14.96	35.99	76
450	30	79	75
540	11.91	48	27.00

1914. III. 23. St. Croix West End. 17° 43′ N 64° 55.5′ W

0	26.00	35.59	23.48
25	25.84	61	57
50	75	61	58
75	40	82	85
100	24.38	36.67	24.81
150	21.98	92	25.70
200	19.55	67	26.17
250	17.70	40	44
300	16.90	31	55
350	15 60	26	82
400	01	13	86
450	12 31	35.50	94
540	10 41	25	27.09

1914. IV. 4. St. Croix West End. 17° 43′ N 64° 55.5′ W

0	26.00	35.59	23.47
10	23.50	61	24.27
25	25	—	—
50	05	35.73	24.49
75	22.80	97	75
100	21.53	36.78	25.72
150	19.33	92	26.42
200	17.77	78	71
250	15.36	44	27.02
300	14.55	33	11
350	20	26	13
400	13.30	35.91	05
450	12.38	71	09
540	10.46	28	11

1914. IV. 18. St. Croix West End. 17° 43′ N 64° 55.5′ W

0	26.20	35.71	23.53
5	23.71	71	24.28
10	62	71	31
25	60	71	32
50	22.62	36.33	25.07
75	42	45	22
100	21.94	71	55
150	19.68	94	26.32
200	17.43	73	75
250	15.57	47	99
300	14.33	36	27.19
350	13.43	09	17
400	12.21	35.91	27
450	11.51	68	23
540	10.56	55	30

At the dates stated below some determinations of temperature and salinities were made at the surface between St. Croix and St. Thomas, about 20 determinations every time. The means were:

1914. II. 26. Temp. 25.1° Sal. 35.66 ‰
» III. 22. » 25.5° » 35.75 »
» IV. 17. » 26.0° » 35.78 »
» IV. 20. » 25.8° » 35.82 »

Surface observations between St. Croix and Calais from 9th to 27th of May 1914.

Time	Lat. N	Long. W	t°	S ‰	Hydrogen-ion-conc.
V. 9. 6 a. m.	18° 40′	63° 35′	26.0	35.37	6.3
» » 6 p. m.	20° 05′	62° 05′	4	86	6.3
» 10. 6 a. m.	21° 20′	60° 40′	25.8	86	6.3
» » 9 p. m.	23° 00′	58° 58′	0	36.36	6.4
» 11. 6 a. m.	23° 50′	58° 05′	24.6	36	6.3
» » 6 p. m.	25° 10′	56° 40′	3	56	6.3
12. 6 a. m.	26° 30′	55° 00′	23.8	55	6 5
» » 9 p. m.	28° 00′	53° 05′	0	92	6.4
» 13. 6 a. m.	28° 50′	52° 10′	21.6	76	6.3
» » 9 p. m.	30° 25′	50° 15′	6	83	6.4
» 14. 6 a. m.	31° 20′	49° 05′	6	76	6.5
» » 9 p. m.	32° 45′	47° 05′	20.8	56	6.5
» 15. 6 a. m.	33° 40′	45° 50′	19.6	36	6.5
» » 6 p. m.	34° 48′	44° 05′	21.6	33	6.5
16. 6 a. m.	35° 55′	42° 15′	8	33	6.5
» » 6 p. m.	37° 00′	40° 20′	19.2	33	6.5
» 17. 6 a. m.	38° 05′	38° 25′	18.6	20	6.5
» » 6 p. m.	39° 10′	36° 30′	1	31	6.5

Time	Lat. N	Long.	t°	S ‰	Hydrogen-ion-conc.
V. 18. 6 a. m.	40° 10′	34° 15′ W	16.3	35.95	6.5
» » 6 p. m.	40° 50′	32° 30′ »	15.9	36.00	6.4
» 19. 6 a. m.	41° 45′	30° 40′ »	8	35.95	6.4
» » 6 p. m.	42° 35′	28° 25′ »	7	84	6.4
» 20. 6 a. m.	43° 30′	26° 20′ »	14.9	73	6.4
» » 6 p. m.	44° 10′	24° 00′ »	15.1	73	6.4
» 21. 6 a. m.	44° 45′	21° 50′ »	14.8	62	6.3
» » 6 p. m.	45° 30′	19° 20′ »	15.7	77	6.3
» 22. 6 a. m.	46° 10′	17° 00′ »	14.2	73	6.3
» » 6 p. m.	46° 40′	14° 10′ »	13.9	57	6.3
» 23. 6 a. m.	47° 20′	11° 25′ »	3	62	6.3
» » 6 p. m.	47° 40′	9° 15′ »	3	59	6.3
» 24. 6 a. m.	48° 05′	6° 50′ »	12.3	52	6.3
» » 6 p. m.	48° 07′	6° 22′ »	7	52	6.3
» 25. 6 a. m.	49° 00′	4° 30′ »	2	16	6.3
» » 6 p. m.	49° 46′	2° 25′ »	6	05	6.3
» 27. 5 p. m.	50° 10′	0° 30′ E	11.8	23	6.2
» » 10 p. m.	50° 43′	1° 00′ »	3	23	—

Observations as to the amount of oxygen.

m Depth metres	t° Temp.	S ‰ Salin.	O_2' ccm. of Sat.	O_2 ccm. obs.	$\frac{100\ O_2}{O_2'}$	Hydrogen-ion-concentration
1913. VII. 16. 60° 12′ N 16° 40′ W						
0	12.11	35.25	6.03	6.52	108.1	—
20	11.63	26	09	7.33	120.4	—
50	9.29	26	39	6.32	98.9	—
75	8.79	28	46	06	93.8	—
100	54	28	49	05	2	—
200	05	25	55	07	92.7	—
300	7.91	23	57	04	91.9	—
400	77	23	59	08	92.3	—
600	50	21	64	00	90.4	—
800	6.83	—	74	5.54	82.2	—
1000	5.54	35.05	94	20	74.9	—
1200	4.71	01	7.09	57	78.6	—
1400	19	34.96	18	86	81.6	—
1913. VII. 22. 55° 07′ N 24° 19′ W						
0	12.08	35.25	6.03	6.34	105.1	—
20	09	25	03	30	104.5	—
50	10.02	25	29	17	98.1	—
100	9.15	25	41	41	100.0	—
200	8.41	19	51	5.95	91.4	—
300	7.95	19	58	99	0	—
400	37	10	66	99	89.9	—
800	5.98	08	87	4.95	72.1	—
1000	4.91	34.96	7.06	93	69.8	—
1400	25	97	17	5.56	77.5	—
1800	3.53	96	29	6.15	84.4	—
2000	42	96	31	17	4	—

m Depth metres	t° Temp.	S ‰ Salin.	O_2' ccm. of Sat.	O_2 ccm. obs.	$\frac{100\ O_2}{O_2'}$	Hydrogen-ion-concentration
1913. VIII. 5. 48° 31′ N 31° 26′ W						
0	16.21	35.03	5.61	6.07	108.2	—
20	14.88	34.97	74	21	2	—
100	8.40	97	6.52	5.80	89.0	—
200	7.10	97	71	50	82.0	—
300	6.35	94	82	58	81.8	—
400	5.52	94	96	67	5	—
600	37	97	98	51	78.9	—
1300	09	97	7.01	18	73.9	—
1800	3.42	92	32	6.33	86.5	—
2000	39	94	33	29	85.8	—
2500	36	96	33	20	84.6	—
1913. VIII. 13. 42° 38′ N 30° 42′ W						
0	22.16	35.86	5.08	5.15	101.4	—
20	20.86	90	18	14	99.2	—
200	12.84	77	93	25	88.5	—
300	57	71	97	25	87.9	—
400	15	66	6.01	09	84.7	—
600	10.91	48	17	12	83.0	—
800	8.91	25	44	4.43	68.8	—
1000	7.35	21	66	50	67.6	—
1200	6 51	25	79	86	71.6	—
1400	5.51	16	95	5.22	75.1	—
1600	4.77	08	7.07	53	78.2	—
1800	69	03	09	56	4	—
2000	25	01	17	87	81.9	—

m Depth metres	t^0 Temp.	S ‰ Salin.	O_2' ccm. of Sat.	O_2 ccm. obs.	$\frac{100\ O_2}{O_2'}$	Hydrogen-ion-concentration
1913. X. 10. 27° 24′ N 52° 40′ W						
100	21.50	—	5.09[1])	5.22	102.6	—
200	18.52	—	33[1])	4.66	87.4	—
600	14.02	—	82[1])	3.84	66.0	—
700	11.99	—	6.04[1])	44	57.0	—
800	10.37	—	23[1])	42	54.9	—
1914. II. 28. St. Croix West End. 17° 43′ N 64° 55.5′ W						
25	25.55	35.48	4.84	4.67	96.5	6.3
50	32	48	86	48	92.2	3
75	32	36.49	82	63	96.1	3
100	24.48	78	87	31	88.5	3
200	20.09	80	5.22	3.88	74.3	3
300	16.62	26	53	95	71.4	2
350	15.50	00	65	78	66.9	2
400	14.96	35.99	70	34	58.6	0
450	30	79	78	22	55.7	0
540	11.91	48	6.06	30	54.5	0
1914. III. 23. St. Croix West End. 17° 43′ N 64° 55.5′ W						
0	26.00	35.59	4.79	4.74	99.0	6.7
25	25.84	61	80	45	92.7	6
75	40	82	84	47	4	8
100	24.38	36.67	89	45	91.0	3
150	21.98	92	5.06	3.98	78.7	8
250	17.70	40	43	4.30	79.2	1
300	16.90	31	50	07	74.0	8
350	15.60	26	63	3.81	67.7	2
400	01	13	69	52	61.9	1
450	12.31	35.50	6.01	08	51.2	0
540	10.41	25	24	2.95	47.3	0

m Depth metres	t^0 Temp.	S ‰ Salin.	O_2' ccm. of Sat.	O_2 ccm. obs.	$\frac{100\ O_2}{O_2'}$	Hydrogen-ion-concentration
1914. IV. 4. St. Croix West End. 17° 43′ N 64° 55.5′ W						
0	26.00	35.59	4.79	4.72	98.5	7.0
10	23.50	61	99	53	90.8	0
25	25	—	5.00	52	4	0
50	05	35.73	02	70	93.6	6.8
75	22.80	97	03	60	91.4	7.0
100	21.53	36.78	10	70	92.2	6.6
150	19.33	92	28	3.93	74.4	8
200	17.77	78	42	4.04	5	2
250	15.36	44	64	12	73.0	1
350	14.20	26	76	3.68	63.9	2
400	13.30	35.91	88	47	59.0	7
450	12.38	71	99	36	56.1	0
540	10.46	28	6.24	2.94	47.1	8
1914. IV. 18. St. Croix West End. 17° 43′ N 64° 55.5 W						
0	26.20	35.71	4.79	4.76	99.4	—
10	23.62	71	97	54	91.3	—
25	60	71	97	41	88.7	—
75	22.42	36.45	5.04	54	90.1	—
100	21.94	71	08	46	87.8	—
150	19.68	94	24	12	78.6	—
200	17.43	73	44	3.84	70.6	—
250	15.57	47	62	4.01	71.3	—
300	14.33	36	75	15	72.2	—
350	13.43	09	86	3.73	63.7	—
400	12.21	35.91	6.00	53	58.8	—
450	11.51	68	09	42	56.2	—

[1]) At the calculation of O_2' the salinity in 100 and 200 metres is supposed to be 37 ‰ and in 600, 700 and 800 metres 35.5 ‰. An error of 1 ‰ in the salinity causes an error of 0.04 ccm. in O_2'.

LITERATURE.

1. 1884. DITTMAR: Report on the scientific Results of the Voyage of H. M. S. Challenger, Physics and Chemistry.
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